PB 207 205

THE ECONOMIC IMPACT OF POLLUTION CONTROL

A Summary of Recent Studies

AN OVERVIEW

Prepared for the

Council on Environmental Quality,

Department of Commerce, and

Environmental Protection Agency

March 1972

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NATIONAL TECHNICAL
INFORMATION SERVICE
Springfield, Va. 22151

AN OVERVIEW

The purpose of this overview is to put into perspective studies which were conducted to assess the economic impacts of air and water pollution abatement requirements on a number of industrial activities.

The studies were conducted under contract with the Council on Environmental Quality, the Environmental Protection Agency, and the Department of Commerce. The Council of Economic Advisers provided guidance on economic methodology for the studies.

The contractors' reports included summaries, detailed analyses, and background data. Reprinted in this volume are the summaries of the reports prepared by the contractors.

Adequate data are not yet available on all the ways in which pollution control requirements will affect industrial activity. Environmental standards as well as the changes being induced in the way materials are extracted, processed, transported, fabricated, consumed and ultimately disposed of are not only extensive but still evolving. Comprehensive studies would require a great deal more time to conduct than was allotted to these preliminary analyses.

In view of these recognized limitations, none of the studies can be considered definitive presentations of total impact on the industrial activities examined or on the economy. However, it is reasonable to believe that the relative relationship of postulated standards and pollution abatement cost consequences are at least indicative of the nature and order of magnitude of the economic impacts.

In general, the studies found that the impact of those pollution control costs that were estimated and examined would not be severe in that they would not seriously threaten the long-run economic viability of the industrial activities examined. However, the estimated impact is not inconsequential in that there are likely to be measurable impacts both on the economy as a whole and on individual industries.

I. BACKGROUND

Pollution abatement regulations have been implemented by government at all levels in order to reduce the substantial and rising costs society has been bearing as a result

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of pollution. These costs are reflected to varying degrees -- sometimes subtly, sometimes directly -- in such factors as increased demands for medical services, property devaluations, lost man-hours of productive work, lower crop yields, shorter useful lives of man-made structures, animal losses, and soiling costs, as well as in such considerations as aesthetics and the quality of life.

In the absence of public action, the full costs to society of producing goods are not reflected in the prices of goods since society rather than the producer bears the costs of pollution. Environmental regulations are a means to "internalize" these costs by requiring producers to bear the costs of pollution abatement. As prices change to reflect pollution abatement costs, consumers can be expected to shift their purchases to relatively less expensive goods which are produced with lower pollution abatement costs. Hence, more low-pollution and fewer high-pollution products will be produced. As a result, less pollution will be created, fewer resources will be required for pollution abatement, and more resources will be available for meeting society's demands for other goods and services.

However, the process of reallocating society's economic resources outlined above can in the short run have adverse as well as positive impacts on society. Specifically, transitional economic dislocations may occur. For example, although sales and employment may be rising in one industry while falling in another, the employees laid off from one industry are not likely to be immediately hired by the other industry due to such considerations as geography, skill requirements, and lack of knowledge of job opportunities.

The purpose of the economic impact studies was to begin to develop a better understanding of the nature and order of magnitude of the adverse impacts of environmental regulations on the economy as a whole and on individual industries and regions within the economy.

Although these studies focused on adverse economic impacts, it should be noted that there will be positive economic impacts as well. An example of positive economic impacts, which were not addressed by the microeconomic studies, is increased profits and employment (a) in the industries that produce pollution abatement equipment and services, (b) the industries that produce relatively low-polluting products, and (c) some of the firms in the industries that are impacted by environmental regulations (i.e., firms that absorb the market shares previously held

by firms that are not efficient when measured by their use of total resources, including the environment, and thus close when they must incur pollution abatement costs).

Examples of positive economic impacts, which were not addressed by either the microeconomic or macroeconomic studies, are (a) possible productivity increases where environmental regulations stimulate technological developments (e.g., changes in production processes which both increase productivity and reduce pollution), and (b) increases in the average level of productivity in some industries as environmental regulations result in the closing of plants that are inefficient in their use of total resources. Further, no attempt was made to quantify the economic benefits of a cleaner environment (e.g., higher crop yield, increased man-hours of productive work) or to compare these benefits with the costs of pollution abatement. Finally, since the macroeconomic analysis employs the conventional national income accounts framework, it overstates the net costs (or understates the net benefits) to society because such accounting fails to include the benefits of a cleaner environment.

II. APPROACH

One macroeconomic study and eleven microeconomic studies were conducted. The macroeconomic study used a computer-based econometric model to determine the impact of pollution abatement costs on such macroeconomic variables as growth of GNP, inflation, unemployment, interest rates and balances of trade and payments.

The microeconomic studies concentrated on major elements of eleven specific industries selected in part because of availability of pollution abatement cost data from the Environmental Protection Agency and in part because they were thought to represent a reasonably complete spectrum of industrial activities that might experience significant dislocations and impacts. The microeconomic studies concentrated on such variables as sales, prices, profits, plant closings, employment and community impacts in the industries studied.

While effects on related (customer, supplier, and competing) industries were examined, the simultaneous impacts on different industries and their cross relationships were not studied in detail.

All of the studies were performed by contractors; the specific industrial activity areas examined and the contractors are listed in Exhibit I.

Exhibit I

ECONOMIC STUDIES

MICROECONOMIC STUDIES	CONSULTING FIRM
Automobiles*	Chase Econometric Associates, Inc.
Baking	Ernst & Ernst
Cement	The Boston Consulting Group, Inc.
Electric Power Generators	National Economic Research Associates, Inc.
Fruit and Vegetable Canning and Freezing	Agri Division, Dunlap and Associates, Inc.
Iron Foundries	A.T. Kearney & Company, Inc.
Leather Tanning	Urban Systems Research & Engineering, Inc.
Nonferrous Metals Smelting and Refining (Aluminum, Copper, Lead, Zinc)	Charles River Associates Incorporated
Petroleum Refineries	Stephen Sobotka & Company
Pulp and Paper Mills	Arthur D. Little, Inc.
Steel Making	Booz-Allen Public Administration Services, Inc.
MACROECONOMIC STUDY	Chase Econometric Associates, Inc.

*All of the microeconomic studies analyzed the impact of the pollution abatement costs associated with assumed air and water emission standards on an industry, except in the case of the automobile study, in which the impact of the cost of the auto-emissions-control device required to meet legislated auto emissions standards was analyzed.

In interpreting the findings of these studies, it is important to be aware of the nature and limitations of the cost data and the key assumptions which were used. Although these are outlined in each report in detail, some of the major considerations are outlined below:

1. Cost Definitions. The investment costs of pollution control equipment were defined to include the direct incremental investment required to attain environmental standards (a) for existing facilities and (b) for new facilities. The operating costs for pollution control equipment were defined to be incremental and net of any productivity increases or by-product revenues. It should be noted that the figures used in these studies sometimes differ from the cost estimates prepared by others. However, in general, a significant portion of such differences can be explained by the fact that the costs were estimated using definitions different from those above.

2. Water Pollution Abatement Costs. The water cost data were estimated under the assumption that the relevant standard is the best practicable treatment -- roughly the industrial equivalent of secondary treatment. If the pending water quality bill set more stringent standards to be met at any time in the next decade, investment and engineering decisions would undoubtedly be affected and higher costs would result.

3. Air Pollution Abatement Costs. The air cost data were estimated in most cases under the assumption that the same set of emission standards would apply in every state. The standards assumed were those published by EPA in the guidelines for developing state implementation plans. If the states adopt different control strategies in order to meet national ambient air quality standards, the costs would vary accordingly. The studies did not include consideration of the proposed sulfur tax.

4. Other Pollution Abatement Costs. Only air and water pollution abatement costs associated with

Federal standards were considered. If localities implement more stringent standards or other standards (e.g., standards for odors), the total pollution abatement costs would be higher than assumed in these studies. Further, although some solid waste costs were reflected in the air and water estimates, these were not comprehensively estimated. Because the volumes of solid waste which will require recovery and disposal will vary appreciably depending upon how air, water and solid waste control requirements are addressed, no meaningful and comprehensive solid waste control costs can as yet be estimated.

5. Phasing. The year in which the pollution abatement costs must be absorbed is a significant determinant of economic impact. For the purpose of the studies, it was assumed that all pollution abatement costs for existing plants and for those to be completed by 1976 would be incurred by 1976. Further, it was assumed that the water pollution abatement costs would be incurred in equal increments over the period and that those for air would be incurred over the 5 year period 1972-1976 in the following annual proportions: 5%, 10%, 35%, 40%, 10%, respectively.

6. Time Frame and Coverage. The microeconomic studies covered only the period 1972-1976. The macroeconomic study covered the period 1972-1980. For the macroeconomic study the cost estimates for the period 1972-1976 included the same estimates as used for the microeconomic studies plus additional estimates of pollution abatement costs for other industries impacted by environmental regulations. For the 1977-1980 period, the cost estimates included (a) the operating and maintenance, interest, and replacement costs on the facilities and equipment installed by 1976 in all industries, plus (b) the capital and operating costs associated with the equipment required for control equipment in facilities expected to be built during the period.

7. Technology. Most cost estimates were based on end-of-line control technologies. Since some of these are still in the early stages of development, the actual cost of these technologies may vary considerably, in either direction, from current estimates. To the extent that firms meet abatement requirements by production process changes

rather than end-of-line controls, the costs employed in these studies could be over-estimated.

8. Inflation. It was assumed that the prices of pollution abatement equipment and services remain constant relative to other prices over the decade. In fact, the prices of pollution abatement equipment and services could rise faster than other prices due to significantly increased demand which is likely to peak in mid-decade. If this occurs, the costs employed in these studies would be understated.

All of the cost data were estimated by the Environmental Protection Agency (EPA). Although the data were examined with the assistance of industry experts identified with assistance of the National Industrial Pollution Control Council (NIPCC), the cost estimates provided to the contractors represented the views of the interdepartmental task force and were not necessarily endorsed by the industry experts. The contractors were asked only to assess the economic impact of the cost data given them. They were not asked to assess the accuracy of the cost estimates. Since definitive cost estimates could not be developed, ranges of estimates were given to the contractors so that they could test the sensitivity of the impact to different cost estimates. However, in some cases, additional cost analyses conducted simultaneously with the economic studies indicated that the actual costs could be higher than even the high range of estimates given the contractors. These additional analyses are noted below in summarizing the contractor reports.

III. MICROECONOMIC IMPACT

The microeconomic studies indicated that none of the industries studied would be severely impacted in that the long-run viability of no industry is seriously threatened solely by the pollution abatement costs estimated. However, profits will decline for some firms in most of these industries because firms will not be able to pass on the full cost of pollution abatement to consumers in the form of higher prices. Costs will not be passed on completely either because substitute or foreign produced products are available so that none of the firms in the industry can pass on their full costs or because the price increases of the smaller firms which have higher unit abatement costs are constrained by those of the larger firms with lower unit abatement costs. Accordingly, some firms will earn lower profits, some will curtail production, and some firms and plants will be forced to close.

However, the studies indicated there will be some price increases as a result of environmental regulations. Depending on the industrial activity in question, prices are likely to rise from 0% to 10% over the period 1972-1976. This is equivalent to average annual increases of from 0% to 2% with the bulk of the increases likely to come in 1974 and 1975.

Most of the firms or plants that will be forced to close are currently marginal operations (e.g., smaller, older, less efficient producers) that were already in economic jeopardy due to other competitive factors. In such cases, the impact of environmental standards is only to accelerate closings that would have occurred anyway. The pollution abatement costs either eliminate already slender profit margins or reduce them to a level at which they fail to justify the required capital expenditures in pollution abatement equipment (in terms of an adequate return on investment).

There are approximately 12,000 plants currently operating in the industrial activities studied. Of these it is expected that approximately 800 would close in the normal course of business between 1972 and 1976. It would appear from the contractors' evaluations that an additional 200-300 will be forced to close because of pollution abatement requirements. Many of these additional closings would appear to involve plants that were vulnerable for other reasons and, hence, that were likely to have closed anyway a few years later.

These plant closings and production curtailments will have both direct and indirect impacts. The direct impacts include the loss of jobs and reduced value of equity. An indirect impact is that related (customer and supplier) firms will be forced to close or reduce production. For example, farms which have marketed their produce to a cannery that closed might be unable to find new markets for their produce. Another indirect impact is that the communities where such plants are located may suffer local recessions--an impact which will be most severe in one-plant towns.

The studies suggest that direct job loss attributable to environmental regulations in the affected industry activities examined may range from 50,000 to 125,000 jobs

over the 1972-76 period*. These figures represent approximately 1% to 4% of total employment in the industry activities studied. The direct average annual unemployment created in these industries represents .05% of the 1970 total national work force. However, the studies suggest that these estimates could be substantially higher if the economy is not at full employment.

While the total plant closings in the industries in which plant closings might have a community impact appear to be about 150, the data presented are not in sufficient detail to determine the number of these communities that will be significantly impacted.

It is important to note that the figures reported in the preceeding paragraphs apply to the industrial activities studied; neither the positive nor negative impacts on other industrial activities have been included. However, in a general sense these other impacts are considered in the macroeconomic study.

In the appendix, a brief description of the impact of pollution abatement costs on each of the industry activities studied is presented.

IV. MACROECONOMIC IMPACT

The macroeconomic study indicated that the national economy will not be severely impacted by the imposition of pollution abatement standards. However, the impact is not insignificant.

In general, the dynamics of impact are as follows. Pollution control costs are assumed to affect the economy in the form of higher product prices and new demands for investments in pollution control facilities by industry ($26 billion in 1971 dollars over the 1972-80 period). Prices rise as a result of the cost-push impact of pollution control costs. In the absence of compensatory macroeconomic policies, the effect of rising prices, which tends to slow the growth of demand in the economy, outweighs the stimulating impact of investments in pollution control facilities.

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*These figures represent the total number of people disemployed as a result of environmental regulations. They are not net figures because they do not account for the number of people (conceivably the same people that are disemployed) who find employment in the industry over the same period. In many industries the net figures indicate that more people find jobs than lose them.

Consequently, the rate of growth of GNP in constant dollars is retarded. The increase in unemployment is tied to the slowdown in real product growth. The current account balance of international trade deteriorates primarily as a result of the increase in domestic prices relative to world prices.* Monetary and fiscal policy adjustments can be initiated to completely offset the slowdown in GNP and employment declines but at the expense of more rapid price rises and further decline in the balance of international trade.

The impact of pollution control abatement costs is discussed below in the context of three alternative projections of the national economy:

- a baseline projection assuming a return to a near full employment economy and no pollution control costs
- the addition of pollution control costs to the baseline projection using best estimates of pollution control costs as well as a variant with costs 50% higher than the best estimates
- the addition of compensatory monetary-fiscal policies and pollution control costs to the baseline projection.

To put these findings in perspective, the key assumptions and possible sources of bias are discussed, followed by a brief description of the methodology employed in this study.

Baseline Projection

The baseline used in this study was constructed to push the economy toward full employment. This trend toward full employment shows the unemployment rate falling to 4.4% by 1976. Over the 1971-76 interval, the value of GNP in constant dollars grows at an average annual rate of 5.2% and consumer prices by 4%.** Because this study concentrates on the changes in the economy due to pollution control costs, the specific details of the baseline case are not at issue here.

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*For lack of data, this exercise assumes that price increases resulting from pollution control occurs only in the U.S. To the extent that similar price rises do take place in the economies of our major trading partners, the trade effects are overstated.

**These guidelines were provided to the contractor before the Phase II economic policy was announced.

Impact of Pollution Control Costs

Constant dollar GNP grows more rapidly in 1972 than in the baseline case as a result of additional demand generated by pollution control investments. However, reflecting the impact of higher prices for consumer and capital goods, constant dollar GNP falls below the baseline in 1973 and remains below the baseline throughout the decade. As shown in Table 1, the annual rate of GNP growth averages .3 percentage points lower over the 1972-76 interval (average annual growth rate drops from 5.2 to 4.9%) and .1 percentage points lower over the decade (from 4.8 to 4.7%). These averages are not fully informative because the assumed time-phasing of pollution control investments concentrated in 1975-1976 lowers the growth rate by one-half of a percentage point in those years, whereas the economy recovers somewhat near the end of the decade.

The impact on prices is felt immediately, with the most significant increases occurring in plant and equipment prices as a result of cost increases in steel, nonferrous metals and electricity. Over the 1971-76 interval, fixed investment prices rise at an annual rate of .5 percentage points above the baseline, while the consumer price index increases by .2 percentage points on an annual basis from a baseline average of 4.0% per year. Here again, the largest price increases occur in mid-decade. Inflationary pressures ease considerably by 1976, and near the end of the decade prices rise at a lower rate than in the baseline case. In large part this is a result of lesser incremental pollution control costs in conjunction with a greater degree of excess capacity in the economy.

The unemployment rate is slightly higher (.1-.2 percentage points from a baseline of 4.6%) over the decade with employment declines nearly offset by new jobs created by pollution control investments.

TABLE 1.--Average Yearly Baseline Level and Absolute Differences From the Baseline

	Units	Input of Best Estimate Of Pollution Control Costs			Input 150% of Best Estimate Of Pollution Control Costs		
		72-76	77-80	72-80	72-76	77-80	72-80
GNP - baseline average	billion of 1958 dollars	872.2	1062.8	956.9	872.2	1962.8	956.9
With Pollution Control Costs (P.C.)		-4.7	-7.6	-6.0	-7.0	-13.1	-9.7
With P.C. and Monetary Fiscal Policy Offsets*		0.0	0.0	0.0	.4	1.6	.9
Annual Growth of Constant Dollar GNP - baseline average	percent	5.17	4.35	4.80	5.17	4.35	4.80
With P.C.		-.29	.16	-.09	-.46	.37	-.09
With P.C. and Offsets		0.0	0.0	0.0	.01	-.01	0.0
Unemployment Rate - baseline average	percent	4.82	4.43	4.64	4.82	4.43	4.64
With P.C.		.1	.15	.12	.18	.28	.22
With P.C. and Offsets		.06	0.0	.03	.04	-.02	.01
Net Exports of Goods and Services - baseline average	billions of current dollars	2.0	.45	1.3	2.0	.45	1.3
With P.C.		-1.2	-.15	-.7	-1.7	.4	-.8
With P.C. and Offsets		-1.5	-2.5	-1.9	-2.3	-4.3	-3.2
Annual Rate of Inflation (CPI) - baseline avg.	percent	4.0	3.73	3.87	4.0	3.73	3.87
With P.C.		.23	-.30	0.0	.34	-.78	-.15
With P.C. and Offsets		.29	.23	.26	.49	.36	.43
Fixed Investment Less P.C. Investment - baseline average	billion of 1958 dollars	124.8	153.6	137.6	124.8	153.6	137.6
With P.C.		-2.3	-2.5	-2.3	-3.5	-2.7	-3.1
With P.C. and Offsets		-1.9	-2.8	-2.3	-2.9	-4.3	-3.4

*The contractor experimented with monetary fiscal policy adjustments to force the economy back to baseline values of GNP and unemployment. In the case in which costs were increased by 50%, the policy offsets do not quite achieve resumption of baseline product and employment paths only because the contractor lacked the time to refine the policy effects.

Fixed investment, excluding those for pollution control purposes, declines slightly over the decade as a result of slower GNP growth, rising prices and a lower level of capacity utilization in the economy. By 1976, investment levels for non-pollution control purposes are 3.2% below the baseline level of $112 billion in 1958 dollars and 1.3% below by 1980. Total fixed investment lies above the baseline until 1976 when pollution control investments fall sharply. The resultant decline leaves total fixed investment $.6 billion below the baseline in 1980.

Net exports of goods and services fall below the base case with imports rising due to domestic price increases. The current account balance declines by more than $1 billion per year over the 1972-76 period from a baseline of $2 billion in current dollars. Less confidence should be placed on the reliability of these trade results because the model deals with such impacts very crudely. However, given the assumption that foreign prices will not increase due to environmental regulations overseas, it is clear that net exports would decline.

Although the previous results were based on best estimates of pollution control costs, another variant was run assuming that pollution control costs were 50% higher, in part to account for any costs which may have been excluded. In general these new results (shown in Table 1) were simply about 50% greater than before for nearly all variables, e.g., GNP growth over the 1972-76 interval slowed by .45 percentage points instead of .3. Thus, except for the unemployment rate, which increased by more than 50%, variations in economic variables were roughly proportional to the percentage variation in pollution control costs.

Impact with Monetary-Fiscal Policy Adjustments

Assuming that the federal government may try to offset some of these impacts, the contractor experimented with monetary-fiscal policy changes in order to bring the economy back to its baseline path with respect to GNP growth and the level of unemployment. Although it is not at all clear that the particular mix of adjustment policies selected by the contractor, relying primarily on government spending, would be the most appropriate one, the results are nevertheless indicative of the magnitude of adjustments required and the impact of expansionary policy changes.

The fiscal stimulus required to return the economy to its baseline growth path is substantial. Federal spending over the nine year projection period sums to over $70 billion above the baseline case, implying annual increases in expenditures less revenues of from $7-10 billion during the last half of the decade.

This stimulus does bring the economy back to the baseline growth path, but in the process it aggravates the impacts on prices and the balance of payments. Inflationary pressures increase slightly in 1972-76 but do not ease off after that period as they did when only pollution control costs were added. For the 1972-80 period, the consumer price index rises by about one-quarter of one percentage point annually above the baseline.

The sustained price increases further aggravate the current account balance, generating an average annual decline in net exports of about $2 billion per year over the 1972-80 period.

Interest rates were essentially unchanged because the policy adjustments employed in the study were designed to maintain stable interest rates.

In this case, the effect of raising pollution control costs by 50% produces somewhat more than proportional impacts on the economic variables. The federal budget deficit must be increased to attain baseline GNP levels while prices and the balance of payments deficit increase by slightly more than 50%.

Assumptions and Sources of Bias

This section looks at issues which may have biased the results in the areas of the basic pollution control cost data, the method of inserting costs into the model and the model itself. Finally, a few comments are made concerning the probable direction of bias in the macro-impact results.

A. The Input Data

(1) Coverage - pollution control costs were included for 15 industry groups which were considered the major sources of industrial pollution. It is probable that other sectors are affected but the empirical impact is expected to be negligible. As shown earlier, pollution control costs are predominately air and water for industry which excludes

costs in the areas of solid waste disposal, governmental water pollution abatement activities and public air pollution abatement. The absence of these figures implies the assumption that there are no incremental costs in industrial solid waste disposal and that no adjustments were made to increase revenues of state and local governments above the baseline projections.

(2) Cost data issues - aside from any difficulties in the engineering cost work, there are some conceptual issues although the direction of possible bias is not clear. For example, investment costs in the water area include a 20% upward revision in part to compensate for down time required to install abatement facilities while down time should be reflected as a decline in production, not as an increase in aggregate demand.

(3) Cost phasing - phasing patterns clearly have an important impact on the timing of economic effects, e.g., assumptions used herein produce the most significant effects in 1974-76. However, it is not clear that other phasing assumptions would reduce impacts over the decade as a whole.

(4) Costs of pollution control facilities - a key assumption underlying the cost data is that the prices of abatement facilities relative to other prices remain constant over the decade. In fact, if new demand is significant enough and especially if demands are bunched, prices of facilities might rise at a much greater rate relative to other prices in the economy. If these effects occur, costs would be understated. Obviously, the time phasing assumption might have a critical impact on the basic cost numbers.

(5) Foreign trade assumptions - no allowance was made in the results for any price increases of world prices as a result of pollution control efforts outside the U.S. or the use of higher cost U.S. goods in production processes elsewhere. To the extent that foreign prices do rise, net exports would rise. Further analyses are to be made that consider increases in world prices. There is also a probability that the U.S. may be exporting pollution control equipment in the future, a factor which could improve the balance of trade but has not been included in this study.

B. Problems of the Treatment of Cost Data in the Model

As mentioned above, a critical assumption in this study is that pollution control costs are entirely unproductive. By making this assumption we have by-passed an area of intense controversy where a great deal of research is now taking place.

Abatement costs are assumed to be based on end-of-line control technologies. In fact, a lower cost approach may be adopted relying on managerial improvements or changes in basic production processes. Such changes would affect the results both with respect to the magnitude of costs which in turn affects the magnitude of increases in prices and in cost of capital.

There are many ramifications of this issue. For example, pollution control efforts may spur increases in labor productivity because of a more rapid adoption of new technologies, which often tend to produce fewer pollutants per unit of output. It can also be argued that cost increases may eliminate marginal firms and thereby average labor productivity could increase if aggregate demand is maintained at full employment. The results also ignore possible feedbacks on labor productivity from improved health, etc., as a result of less pollution which could lead to results different from those indicated by the study.

C. Problems with the Econometric Model

It is not clear at this point what the nature of bias may be from incorrect specification in the model itself. Clearly the model was not designed to handle the special case of pollution control and thus refinements could be made (such as production functions by industry to account for productivity impacts varying with pollution control technologies). Whether such changes would substantially alter the results reported is not known. One part of the model which may be weak is the trade sector, which is quite simple, including only 4-5 sectors. For example, if imports fall off more than proportionately as GNP declines, then net exports would not fall as

much as they do in current results. Another issue is the inability of the model to capture employment loses due to plant shutdowns or cutbacks as profits, in some cases, are squeezed. Because the model relates unemployment only to aggregate variables, it may understate the impact of pollution control costs on unemployment. While we are not sure bias in the model is significant, we do believe that further study and refinement may be warranted in order to realistically capture pollution control impacts.

D. Possible Direction of Bias

As a result of this complex set of qualifications, in which some have biases in opposite directions and other factors have unknown effects, no statement can be made with confidence about the direction of net bias in the present study.

Methodology

Pollution control costs are assumed to affect the economy in several respects: The efficiency of capital in the aggregate production function is reduced, prices of consumer and capital goods increase, the cost of capital per unit output increases and finally pollution control investments generate new output and employment in industries producing abatement facilities. It is worthwhile emphasizing that the quantitative magnitude of the first three negative impacts hinges importantly on our assumption that pollution control costs are entirely "unproductive" in the sense of generating new capacity in industrial establishments.

A. Prices

Annual costs in the form of percentage cost increases were inputed into the industrial sector of an input-output table. These cost increases are initially converted to first-round price increases by industry markup factors which range from .8-1.0. These price increases are then passed on through other industries which use other products as inputs, assuming that all raw material price increases are passed on 100%. After taking account of these inter-industry effects, these price increases were passed on through another series of markup factors for final demand components, such as cars, shoes, and

plant and equipment. This set of price increases is then used to move the economy off the baseline growth path.

B. Aggregate Production Function

Pollution control investments are included as a factor boosting aggregate demand in the economy, thereby generating output and employment, but were not considered to augment the productive or capacity-augmenting capital stock of the nation. No adjustment was made for reducing the efficiency of labor in the aggregate production function, although this effect is probably small compared to that for capital stock.

C. Cost of Capital

Since pollution control expenditures are assumed not to be capacity-augmenting, some further adjustment was necessary to reflect the negative incentive this would have on industry's consideration of new investments which would augment capacity. This adjustment was necessary because the determination of investment in the macro model did not explicitly consider the impact of more capital required per unit of output. This was done by boosting the "user cost of capital" by the ratio of pollution control costs to baseline investment levels. Conceptually, this is equivalent to raising the cost of capital needed to produce a unit of output. To provide some feeling for the complicated set of factors which affect investment (excluding pollution control) demands in the model, we note that it is negatively affected by the slowdown in GNP growth, the rise in capital goods prices, the rise in the cost of capital and by the decline in the degree of capacity utilization. Offsetting these factors to some degree, investment demand is stimulated by the increase in wholesale prices.

APPENDIX

AUTOMOBILES

The study of the automobile industry differed from the studies of all other industry activities. In all other cases the studies focused on the impact of air and water pollution control costs required in the production process itself, while the auto study focused solely on the impact on the industry of air pollution control equipment to be installed on vehicles.

The installation of required pollution control equipment on automobiles and small trucks was estimated to add approximately $350 to the cost of manufacturing a vehicle by 1976-77. This is the same estimate as reported in EPA's Economics of Clean Air. Since approximately $35 of the $350 was already in place by the 1972 model year, only $315 remained to be added. The contractor rounded this figure to $300, but included a range of ± 30% in estimating the impact of the cost increase on the industry. The range which he used for cost increase after the 1972 model year is therefore $210 to $390. The cumulative cost increase over the uncontrolled car is $35 higher or $245 to $425.

The contractor was also given an estimate of increased operating and maintenance costs of $65 annually or $325 over a five year period (approximately 50,000 miles). However, these costs were not employed in the analysis because the contractor was unable "to reject on either statistical or theoretical grounds the hypothesis that for this range of additions to operating costs the response of new car purchases is negligible." The high estimate (i.e., $425) may or may not capture any impact which these costs might have on auto sales.

It is important to note that the purpose of this study was to assess the impact on the automobile industry of the requirements of the Clean Air Act. It does not include cost increases which can be expected from new safety regulations, costs which some studies suggest are of a magnitude equivalent to those for control of pollution. The increased costs from the two sources, control of pollution and new safety features, could have impacts on the industry which are more than proportional to the sum of these costs.

The contractor's study of demand relationships for all automobiles and among the different classes of automobiles indicated that from 84% to 98% of the cost increases associated with air pollution control equipment will be passed on to consumers in the form of higher automobile prices. Thus the price of sub-compact cars was expected to rise approximately $294 by 1976-1977 because of required installation of pollution control equipment. The price of luxury cars was expected to rise approximately $343.

This increase in automobile prices was expected to have two effects upon automobile sales. First, some change was expected in the class of car purchased. In comparison with baseline projections, sub-compact automobiles were expected to lose 0.25% of the market, and standard sized automobiles 1.6%, by 1980 because of the cost of pollution control equipment. This market share would be absorbed to some extent by compacts, intermediate, and luxury cars (0.26% to 0.4%); and to a greater extent (0.8%) by a new class of cars, the sub-sub-compacts,which was expected to be a factor in the market by that time.

It was also expected that because of increased automobile prices, the total sales of new automobiles will be decreased. Projections indicate that, in comparison with baseline estimates, the total number of new passenger car registrations in 1976 would be reduced by 420,000 or 3% from 13.31 million to 12.89 million; in 1980 a reduction of 180,000 or 1.2% from 14.53 million to 14.35 million was expected.

The reduced sales of automobiles through 1980 are expected to lead to some reduction in employment from the baseline projections, especially in the period 1973 through 1977. Although total employment in the automobile industry is not expected to be reduced below current employment at any time, the growth in employment will be slower than the baseline projections and in some years employment will be reduced from the previous year's level.

The maximum reduction in jobs from baseline projections was 1.8% or 18,000 jobs in 1976, from 1,025,000 to 1,007,000. Only in one year, 1975, is the total number of jobs in the industry reduced below the previous year's level. In that year jobs are expected to decline by 13,000 or 1.3% from 979,000 to 966,000. By 1980, it is expected that industry employment will be 0.9% or 9,000 jobs below the baseline projection of 1,044,000.

In eleven other industries significantly affected by these changes, total employment in 1976 is expected to be 0.25% or 35,000 jobs below the baseline projection of 13,119,000.

By 1980, however, total employment in these industries is expected to be 53,000 or 0.35% above the baseline projection 15,273,000.

Because the contractor assumed a substantial increase in imports of sub-sub-compact cars, the U.S. balance of payments is expected to be adversely affected by the increased automobile costs associated with pollution control equipment. The annual net exports of goods and services of the U.S. are expected to be reduced by a maximum of $700 million in 1980.

BAKING

Total investment required to meet water pollution control standards associated with the baking process from 1972 through 1976 was estimated to be $11.8 million to $21.3 million. Annual costs were estimated to increase from $0.4 million in 1972 to $2.0 million in 1976. Average costs per pound of products were estimated to range from 0.011¢ to 0.02¢ for bread and related products, and from 0.05¢ to 0.09¢ for biscuits and crackers.

Because costs of pollution abatement in the baking process are so low--0.2% of sales--no impact was expected in the bakery products industry.

CEMENT

Capital expenditures required from 1972 through 1976 to meet air and water pollution control requirements associated with the manufacturing of cement in kilns and clinker coolers were estimated to total $122 million. Annual costs were estimated to increase from $3.0 million in 1972 to $43 million in 1976. These costs average out to $0.08 to $0.10 per barrel of cement.

Projections of cash flow and capital needs including pollution abatement expenditures for the cement industry through 1980 indicated that the industry will be able to meet its cash needs. Given the most severe set of assumptions, however, many changes in the industry's financial policies would be required. These would include a reduction in the divident payout ratio from 59% to 49%, and an increase in the debt/equity ratio from 0.39:1 to 0.6:1. Both of these were considered manageable. Alternatively, a 4%-5% real price increase would be employed to provide most of the required funds.

Pollution control costs in the cement industry were expected to accelerate the current trend in the industry toward the closing of small, old plants and the construction of large, modern facilities. This, in turn, would increase the capital pressure upon the industry. The combined effect has been estimated to result in the closing of approximately 25 cement plants in the 1972-1976 period. The additional impact upon cement industry employment was expected to be minimal. Only one possible community impact has been identified.

The increase of prices because of pollution controls was expected to accelerate the current increase in cement imports. No estimate of the magnitude of this impact has been made, however.

ELECTRIC POWER GENERATORS

It was estimated that the total investment required to meet air and thermal pollution control requirements associated with the generation of electricity from 1972 to 1976 will be $10.7 billion. Of this, $7.5 billion would be required for air pollution control, and $3.2 billion for thermal pollution control. It has been suggested that the cost of installing pollution control equipment on existing plants might be twice those included in these estimates. If so, the total investment required through 1976 would reach $17.8 billion. Annual costs associated with pollution controls were estimated to rise from $338 million in 1972 to $2.5 billion in 1976. Costs per kilowatt hour in 1976 would range from 0.22 mills to 1.52 mills depending upon the region of the country. These costs did not include additional costs that might be required for the control of nitrogen oxides and radiation.

The impact of pollution control costs will vary from region to region across the U.S. depending upon the source of energy employed. In the West South Central, for example, almost all generators are gas-fueled, and will require almost no air pollution control facilities. Consequently, pollution control costs in this region in 1976 were estimated to total only 2.8% of 1970 average revenues. In the Tennessee Valley Authority region, on the other hand, approximately 80% of the generating facilities are coal-fired. These will be faced with the full cost of air and thermal pollution controls. This, combined with a low revenue level, was estimated to lead to pollution control costs in 1976 totaling 10.65% of average 1970 revenues. The average of all regions' air and thermal pollution control costs in 1976 was estimated to be 7% of 1970 average revenues.

In the philosophy of utility regulation, justified cost increases are passed on to the consumer. Thus, it can be assumed the above costs will ultimately be passed on completely to the electric ratepayers through higher electricity rates. Past experience, however, indicates that the passing on may not be complete and in any event will occur with some delay. Furthermore, given the complexity and variety of rate structures, it was not possible to determine how these price increases might be distributed among the various categories of consumers.

No adequate information was available on the demand responsiveness of the users of electricity to changes in electricity's price. The total demand for electricity was judged to be extremely unresponsive to price.

Six industries were identified for which electric power costs amounted to 5% or more of the total value of shipments. These are Atomic Energy Commission plants, primary aluminum, electrometallurgical products, alkalies and chlorine, industrial gases, and hydraulic cement. The anticipated increase in the price of electricity was expected to have little impact, even upon these industries.

FRUIT AND VEGETABLE CANNING AND FREEZING

Water pollution abatement regulations were estimated to require the investment of approximately $120 million by the fruit and vegetable canning and freezing industry through 1976. Annual costs of pollution control equipment were estimated at $4.3 million in 1972 increasing to $21.3 million in 1976.

In the fruit and vegetable canning and freezing industry, the largest third of the plants produce about 80% of total industry volume. These plants enjoy a considerable cost advantage over the remaining plants, and are consequently much more profitable. This advantage has created a trend over the past 10-15 years toward fewer and larger processing plants. Census figures indicate that from 1958 to 1967 the total number of fruit and vegetable canning plants declined 25%. The number of fruit and vegetable freezing plants more than doubled from 1958 to 1964, but then decreased 6.6% through 1967. Both of these trends were expected to continue through 1980 with a 25% decrease projected from 1971 through 1980.

It was expected that the larger canning and freezing plants will also enjoy a cost advantage in installing and operating pollution control equipment. For those plants which must install their own facilities, for example, the price increase that would be required to offset abatement costs would be 5.5% for large plants, but 9.6% for small plants.

Given estimates that half of the plants will be able to find lower cost abatement solutions, and that 58% of the projected abatement technology is already installed, actual price increases were not expected to be as high as above. Prices were expected to rise 1.4% to 2.3%. Such an increase would cover the average costs of the larger producers, but not of the smaller plants.

The increased prices were expected to lead to a 0.5% to 1.0% decrease in consumption. Such a decrease would be less than the total annual increase expected in consumption because of population expansion and increases in per capita consumption.

The increased costs of pollution control were expected to further reduce the profits of the already marginally profitable small plants. Many of these plants will be able to tie into municipal systems or to find other low cost pollution abatement techniques that will enable them to stay in business. Experience in some states indicates that half of the small plants might be unable to find such alternatives. In this case, up to half of the small plants in the industry, or one-third of all plants, were expected to be forced to close. Of the 1,200 plants included in the industry directory, therefore, 400 might be forced to close because of pollution abatement costs. As noted above,

25% of the plants, or 300 of the 1,200, would be expected to close by 1980 in any event. Thus, the addition of pollution control costs was expected to lead to the additional closing of 100 plants, or 8.3% of the total. In addition, closing of the other plants was expected to occur some years earlier than otherwise.

It was estimated that the closing of 400 plants would result in the loss of jobs by approximately 28,000 employees. The disemployment created by the 100 plants that were estimated to close because of pollution controls would be one-fourth of that number or 7,000. Many of these would be in small towns and rural areas where reemployment would not be readily available. Up to 90% of the jobs lost would be part-time positions.

Because many of the plant closings would be in small towns or rural areas, the community impact of these closings could be significant. This would be further complicated if the farmers in the surrounding areas are unable to find alternate markets for their products. This possibility was suggested, but no careful analysis has been made of the experience in such cases or of the technical factors involved. Accordingly, no estimate is available for the magnitude of this impact.

The impact of increased prices in the industry upon the U.S. balance of payments was expected to be small.

IRON FOUNDRIES

Approximately $348 million in capital expenditures was estimated to control the air pollution associated with the making of iron castings through 1976. Annual costs of pollution control equipment were expected to increase from $6.2 million in 1972 to $125 million in 1976. Average costs per ton of castings produced would depend upon plant size, with an expected range of $2 per ton for large producers to $14 per ton for small producers.

The iron foundry industry is composed of a relatively small number (30%) of large producers whose costs and investment per ton of castings are less than half of the smaller producers'. From 1947 to 1969, the total number of foundries has declined from 3,200 to 1,670. Most of these closings have involved small foundries which have been unable to raise capital to modernize. This trend is expected to continue through 1980, with the additional closing of some 670 foundries.

Requirements to install pollution control equipment were expected to intensify capital availability problems, and thereby accelerate the rate of plant closings. It was estimated that approximately 10% of these 670 closings would be caused wholly or in large part by pollution control requirements. In an additional 50% of the closings, pollution control costs were expected to be a significant factor.

Pollution control costs will range from 1.5% to 4.0% of sales. Price increases of 1.7% to 5.0% were expected to be necessary to cover these costs and to preserve current rates of return. Such increases were estimated to be possible with a negligible effect upon demand.

Total employment loss in all plants projected to close by 1980 was estimated at 26,600, It was expected that approximately half of these would be reemployed in other iron foundries. The net unemployment was therefore estimated to be 13,300. For the 60% of the plant closings in which pollution control was expected to be a factor, disemployment would be approximately 16,000 with a net unemployment of 8,000.

Approximately 2,250 of these 13,300 unemployed workers would possess transferable skills. The remainder would be unskilled, and was therefore expected to experience difficulty in obtaining reemployment.

Because foundries are generally located near industrial markets, it was not expected that many communities will be severely impacted by the projected closings.

Some increase was expected in imports of iron castings because of increased costs in the U.S. Because imports currently account for 0.1% of the U.S. market, these increases were not expected to be significant.

LEATHER TANNING

The total investment required of the leather tanning and finishing industry between 1972 and 1976 for water pollution abatement equipment was estimated at $89 million. Annual pollution control costs were expected to rise from $2.1 million in 1972 to $10.7 million in 1976.

A survey of the costs of pollution control alternatives available to leather tanneries found that, on average, pollution control costs were less than or equal to 1% of sales. At most, costs were found to be 2%-3% of sales. Such costs were estimated to be well within the capacity of the industry, which frequently experiences increases and decreases in the costs of its raw-material hides of as much as 50% to 100% in a one to two year period. Selling prices have correspondingly changed from 10% to 25% in the same period with no apparent affect on production. Thus, it was assumed that cost increases of 1%-2% because of pollution controls could easily be passed on by the industry.

Available financial data and an industry survey were interpreted as indicating that those firms which were not likely to close for other reasons would be able to finance the required capital expenditures. It was estimated that a few small, marginal firms might close more quickly because of pollution control costs, but this impact was judged to be slight.

The aggregate effects on employment or production in the leather industry as a result of pollution control costs were estimated to be minimal. The closing of beam houses by some firms was expected to result in the unemployment of some 600 workers. These job losses were expected to be widely scattered geographically, however, with no important community impacts. Some subsequent increase in employment was expected where the beam house work would be picked up.

NONFERROUS METALS
SMELTING AND REFINING
ALUMINUM

Total investment expected to control the air and water pollution associated with the smelting and refining of aluminum for the period 1972 through 1976 was estimated at approximately $935 million. Annual costs were estimated to range from $22 million in 1972 to approximately $290 million in 1976. Cost increases per pound of aluminum in 1976 would average $0.020 to $0.032.

Although the required capital expenditures are large, aluminum producers were judged to have the necessary financial resources.

Cost increases are expected to be passed on to consumers of aluminum. Historically, demand for aluminum has been sensitive to price. Thus it was expected that by 1976 price increases of approximately 5%-8% will lead to a level of aluminum consumption 4%-6% lower than would otherwise have existed. In the longer run, price increases of approximately 10% were expected to lead to a 13% reduction in aluminum consumption. This does not mean that the demand for aluminum would be reduced below current levels. Instead, demand would not grow as fast as would otherwise be expected.

It was not expected that pollution control costs will force any existing plants to shut down, although it is possible that some of the other plants may be closed sooner than otherwise. No decline of employment in the aluminum industry was expected because of pollution controls. As with demand for production, employment would not grow as fast as otherwise.

Increased costs were expected to have an adverse effect upon the U.S. balance of payments by leading to a decline in U.S. exports of ingot and mill products and an increase in U.S. imports of mill products.

The latter effect might be especially severe because pollution control costs may lead to new aluminum smelters being located outside of the U.S. No total estimate of the balance of payments effect has been made, although it was noted that the eventual decline in exports may total $100 million to $200 million.

Because of the uncertainties associated with the financial capacity of the industry and the economics of individual smelting and refining plants, further study is currently being made of the impact of pollution abatement requirements upon the aluminum industry.

NONFERROUS METALS
SMELTING AND REFINING
COPPER

The capital investment required in the copper industry, because of air and water pollution controls from 1972 through 1976, was estimated to total $300 million to $690 million, with a most likely estimate of $341 million. Annual costs were expected to increase from $6 million in 1972 to $95 million in 1976. Per pound of refined copper, these costs average $0.001 in 1972 and $0.025 in 1976, with a possible high estimate of $0.05 in 1976.

It is expected that the industry can finance the required capital expenditures.

The effect of cost increases has beer analysed considering a basic projection for the copper industry without pollution control costs; and two alternative assumptions: (a) that foreign competition will not compete in the U.S. market, so that U.S. producers are able to raise prices, and (b) that foreign competition will prevent any price increase in the U.S. market as a result of pollution control costs. It was assumed that the actual impact of pollution control costs will lie somewhere between these two extremes.

If the average pollution control costs are considered, (a) U.S. production of copper in 1980 was expected to be approximately 7% less than the base projections of 4,169,000 short tons if foreign competition prevents price increases while prices and consumption would not change; (b) U.S. production would be 3.5% lower than base projections; U.S. consumption 4.6% lower; and U.S. prices 4% higher; if foreign competition is not a factor.

If costs equal the highest estimates, (a) U.S.production would be 14% lower than projected, if no price increase is possible; (b) U.S. production would be 7.4% lower; U.S. consumption 9% lower, and U.S. price 8% higher, if low foreign competition permits price increases.

Thus depending upon costs and foreign competition,it was estimated that U.S. supply be reduced 3.5% to 14% and U.S. consumption 0% to 9%;and U.S. prices may increase 0% to 8% because of pollution controls.

It was estimated that most existing U.S. smelters will continue to operate under pollution control requirements. Two smelters were identified, however, as being forced to close. No estimate was made of additional smelters which might close.

With the imposition of pollution controls, employment in the copper industry was not expected to decline, but would grow more slowly than the base projections. Without pollution control costs, employment was expected to grow from 54,000 in 1970 to 76,900 in 1980. Pollution control costs were expected to reduce the 1980 employment by 2,800 to 10,900 or 3.6% to 14% depending upon the cost and foreign competition assumptions discussed above. Where individual smelters close, of course, all workers would become unemployed. The two smelters identified as closing currently employ 1,150 employees. No estimate was made of the associated mining employment. In both instances, a significant community impact was expected.

No estimate was made of the effects of pollution controls in the copper industry upon U.S. balance of payments. In the extreme case, it was mentioned, all new smelting capacity might be located offshore. This would mean that the current capacity of 3,066,000 short tons would not be expanded to the predicted 4,169,000 short tons in 1980, a reduction of 26% from the baseline trend. This would have substantial financial and employment consequences within the industry in addition to the balance of payments effects.

As with the aluminum industry, further study is being made of the copper industry to ascertain on a plant by plant basis the costs of pollution controls and the economic viability of the controlled plants.

NONFERROUS METALS
SMELTING AND REFINING
LEAD

The total capital expenditure required to control the air and water pollution associated with the smelting and refining of lead was estimated at about $70 million for the 1972-1976 period. Annual costs were expected to increase from $1.1 million in 1972 to $20 million in 1976. Costs per pound of lead in 1976 were estimated as $0.012 to $0.017, with a best estimate of $0.014. These studies did not consider the substantial changes in the lead markets that will be caused by other pollution abatement regulations such as those which would lead to reductions in the lead content of gasoline.

The U.S. lead industry currently can be divided into the low-cost producers in Missouri which account for 55% to 60% of U.S. production; and the high-cost producers located elsewhere. Estimates of production and pollution control costs indicated that the low-cost producers would be able to raise the required capital and to maintain production even if forced to absorb pollution control costs. High-cost producers, on the other hand, may not be able to raise the required capital. If some are forced to close, this will be an acceleration of the current industry trend which could be expected to continue even in the absence of pollution control costs. Any price increases were expected to be small, reflecting the costs of the low-cost producers. One estimate was of an increase of $0.007 per pound or 5%. Such an increase was not expected to alter the trend towards the exit of high-cost producers.

Because the demand for lead was not very sensitive to price, no significant reduction in lead consumption was expected to result from pollution control costs. The shift in production toward the less labor intensive, low-cost producers was expected to result in a net loss of employment in the industry even in the absence of pollution control costs. One smelter which was expected to close soon would result in the unemployment of some 200 persons. Fewer employees would be needed in the low-cost smelters which pick up this demand, and none would be needed in the community where the plant closes.

No estimate was made of the impact of pollution control costs in the lead industry upon the U.S. balance of payments. Some increase in imports were expected, of course, if prices are raised, but the expected price increase was judged to be small. No incentive to relocate smelters abroad is anticipated. Further study is being made of the economic impact of pollution abatement regulations on the lead industry.

NONFERROUS METALS
SMELTING AND REFINING
ZINC

During the period 1972-1976 it was estimated that $62 million of capital expenditures will be required to control the air and water pollution associated with the smelting and refining of zinc. Annual pollution control costs would increase from $1.5 million in 1972 to $27 million in 1976. These would average $0.0123 to $0.0267 per pound, with an expected cost of $0.0135 per pound.

The U.S. zinc industry can be segmented into high-cost and low-cost producers, with a trend toward the exit of high-cost producers from the industry. Because pollution control costs were expected to fall upon high-cost producers more heavily than upon their low-cost competitors, and because price increases were not expected to equal pollution control costs, some acceleration in the closing of high cost facilities was expected from pollution abatement regulations.

An analysis of prices and average production costs for low-cost producers indicated that these producers would be able to absorb pollution control costs and raise the necessary capital even if there is no resultant price increase. It is possible, however, that such a situation would inhibit the expansion of some low-cost producers. No similar analysis was conducted for high-cost producers. It was assumed, however that because the profit margins after absorbing pollution control costs were so small for low-cost producers, that the margins of high-cost producers would be reduced below the opportunity cost of capital and possibly to a loss. Given the pressure of imports and substitute materials, it was not expected that price increases could be large enough to alter these conclusions.

Total employment in the zinc industry is expected to decline in the long run, with three or four smelters closing, even in the absence of pollution controls. The trend would be hastened by abatement requirements, but no estimate was made of the time periods involved. Total employment in the smelters expected to close was approximately 3,000. No estimate of related mining employment was made.

The accelerated demise of high-cost producers and the cost increases for low-cost producers would have a number of effects on the U.S. balance of payments. The closing of some U.S. smelters and the inhibition of expansion of others would lead to an increase in zinc metal imports. This would be partially offset by the reduced imports of concentrates formerly used

by high-cost producers. Additional imports of zinc metal were estimated to reach $78 million to $124 million per year. No estimate was made of decreased imports of zinc concentrates.

Further study of the zinc industry is being conducted to ascertain the impacts of pollution abatement requirements on individual smelting and refining plants.

PETROLEUM REFINERIES

From 1972 through 1976, it was estimated that the petroleum refining industry would be required to make capital expenditures of $634 million to $1155 million to meet the air and water pollution abatement requirements that apply to the refining of petroleum. Annual costs of $2 million in 1972 rising to $21 million in 1976 would also be required. In addition, the cost of using low sulfur fuels in refinery operations was estimated to be $108 million annually by 1976. The average pollution abatement costs per barrel in 1976 were estimated to be $0.06, thus increasing the total cost per barrel by approximately 1.4%.

Because capital expenditures for pollution control equipment would equal only 5% of the $21.4 billion capital expenditures otherwise projected for the industry in the next ten years, it was considered that these expenditures would be manageable. A price increase of $0.08 per barrel was expected to help defray the added costs. In addition to the annual costs mentioned above, this $0.08 figure included an 8% return judged to be necessary to attract the capital required to install control equipment in new facilities. This price increase was assumed to be possible because imports are restricted by law and the demand for petroleum is not elastic.

Given this $0.08/bbl. price increase, it was estimated that most small producers will be able to sustain added pollution control costs. A few, perhaps 12, might be forced to close.

If a dozen small refineries do close, approximately 1,000 workers would become unemployed. These small refineries would probably be located near smaller communities, and thus would have a noticeable local impact. Otherwise, industry employment is expected to increase at about the rate projected without pollution control costs.

If desulfurization of the liquid fuels used in refinery oeprations is required, additional imports of such fuels were estimated to cost $40 million per year. No other balance of payments effects as a result of pollution abatement requirements on refinery operations were estimated.

This study did not take into account a number of major changes likely to occur in the petroleum industry. These include federal requirements for making lead-free gasoline available, restriction of lead content in leaded gasoline, higher average sulfur content in crude oil supplies, and higher market demand for desulfurized residual oil. Further, although environmental regulations will impact almost every aspect of the petroleum industry from exploration through production, transportation and refining to marketing, only

the pollution abatement costs related to refinery operations have been estimated. Consideration of the full impact of environmental regulations on the petroleum industry could result in substantial increases in capital requirements and operating costs above those estimated for this study. Additional studies of pollution abatement costs and the economic impact of these costs will be undertaken. The findings of these studies will be made available on completion.

PULP AND PAPER MILLS

Approximately $3.3 billion was estimated to be required in capital expenditures by the paper industry for the period 1972-1976 to meet air and water pollution abatement requirements. Annual costs per ton of product were estimated to range from $5.50 to $12.50 depending upon product sector.

Because of an anticipated tightening of supply/demand balances, price increases were expected in the paper industry. These increases were likely to reflect the above-mentioned annual costs of pollution controls. Increases of this magnitude would represent a 3.5% to 10% increase over current prices depending upon product sector.

Given these increases it was anticipated that most mills will be able to manage pollution control expenditures. However, of the 752 pulp and paper mills in the U.S., 329 accounting for 15% of U.S. production have been identified as marginal. These mills currently have profit margins much below industry averages (-7.7% to 4.8% vs 6.6%) and may experience pollution control costs approximately twice as large as industry avarages. Price increases were not expected to cover their increased costs. This will reduce already low profit margins and create some difficulty in raising the capital required for pollution control equipment.

Even in the absence of pollution control requirements, 30-35 of these marginal mills were expected to close in the 1972-76 period. It was estimated that an additional 60-65 mills would be forced to close with the imposition of abatement regulations. These additional closings were expected to result in the loss of 16,000 jobs by 1976. A larger number of jobs will be made available in plants which are expected to expand, but these of course may not be in the same community. Many of the shut downs are likely to be in rural areas where they would have significant community impact.

Assuming that pollution abatement measures will be similar in all paper producing countries, it was not anticipated that pollution abatement costs would significantly affect the international competitiveness of U.S. paper products.

STEEL MAKING

Capital expenditures required by air and water pollution abatement regulations were estimated to total $2.4 billion to $3.5 billion for the period 1972 through 1976. Annual operating and maintenance costs were estimated to be $45 million to $70 million in 1972, increasing to $760 million to $1,100 million in 1976. Per net ton of steel shipped, these costs would average from $0.47 to $0.73 in 1972 and $6.60 to $9.60 in 1976.

Price increases to cover pollution abatement costs would be necessary to generate the cash required to meet projected expenditures. The estimated 0.7% to 1.5% annual increases were considered moderate, however, in relation to historical price increases.

It was expected that most facilities would be able to install pollution abatement equipment and continue operation. This conclusion was strengthened by the fact that the demand may exceed the capacity of the industry to supply steel so that the industry would need all of its current capacity.

The possible effect of price increases upon the U.S. balance of payments was assumed to be negligible because of continued voluntary import restrictions, the re-alignment of currencies, and the moderate size of expected price increases.

Because the estimates of the industry's ability to finance the required capital expenditures and to maintain operations in the less modern facilities are sensitive to several key assumptions (e.g., substantial increases in demand for domestic steel, current industry capacity), additional analysis is being conducted to confirm the validity of these assumptions.